Implementing Barcoding in SQL*LIMS

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- **Savannah River Site is a Department of Energy Facility**
- **Located in Aiken, SC**
- **Primary work is environmental restoration**
- **Multiple laboratories across the Site**
  - Ranging from large to small labs doing a variety of work
- **Combined Barcoding experience in department is 50 man-years plus**
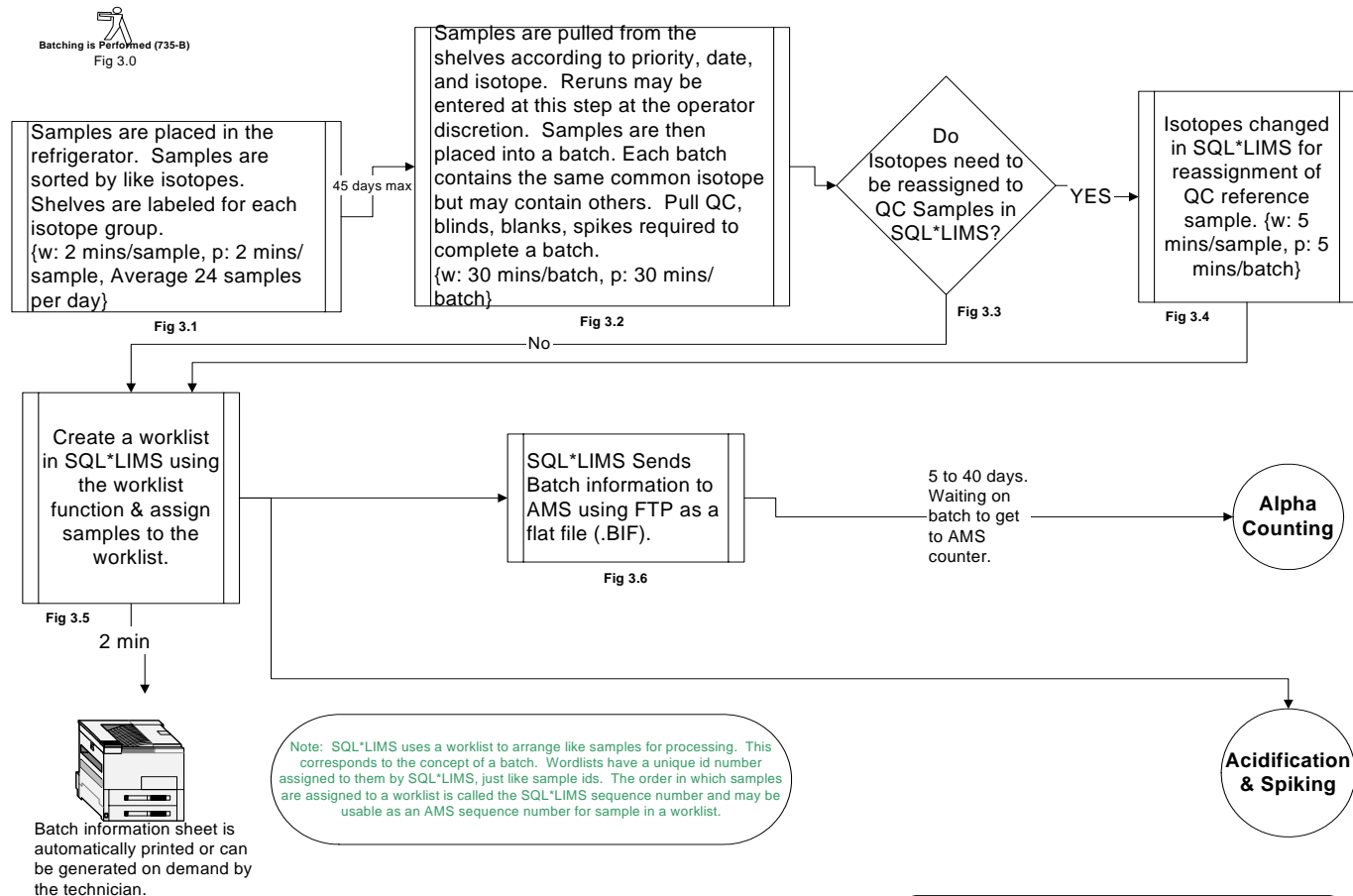 - Have recognized experts in barcoding at Site

- ## How to engineer implementation of barcoding in the SQL*LIMS lab
  - A step by step engineering approach
  - Provides insight into hidden issues (or avoiding "*Opps! I did not think of that!*")
- ## How to measure success
  - Set the conditions for success
  - Ensuring goals are reasonable ("*Sure... We can do that!*")
- ## How different strategies can be used implement barcoding in SQL*LIMS

- Avoids operator transcription errors

- Allows for quicker inventory of samples spread out across multiple labs

- Reduces process times and increases work efficiency

- Eases operator tedium

- An Engineering Workflow is needed to map the process
  - Primary and critical step
  - Basis for all decisions
  - Allows verification of improvements
- Record real work vs. process time for each step before barcode implementation
- Identify sample environment
- Identify sample life in the workflow

Batching is Performed (735-B)
Fig 3.0

Samples are placed in the refrigerator. Samples are sorted by like isotopes. Shelves are labeled for each isotope group.
{w: 2 mins/sample, p: 2 mins/sample, Average 24 samples per day}

Fig 3.1

45 days max

Samples are pulled from the shelves according to priority, date, and isotope. Reruns may be entered at this step at the operator discretion. Samples are then placed into a batch. Each batch contains the same common isotope but may contain others. Pull QC, blinds, blanks, spikes required to complete a batch.
{w: 30 mins/batch, p: 30 mins/batch}

Fig 3.2

Do Isotopes need to be reassigned to QC Samples in SQL*LIMS?

Fig 3.3

YES

Isotopes changed in SQL*LIMS for reassignment of QC reference sample. {w: 5 mins/sample, p: 5 mins/batch}

Fig 3.4

No

Create a worklist in SQL*LIMS using the worklist function & assign samples to the worklist.

Fig 3.5

2 min

SQL*LIMS Sends Batch information to AMS using FTP as a flat file (.BIF).

Fig 3.6

5 to 40 days. Waiting on batch to get to AMS counter.

Alpha Counting

Batch information sheet is automatically printed or can be generated on demand by the technician.

Note: SQL*LIMS uses a worklist to arrange like samples for processing. This corresponds to the concept of a batch. Wordlists have a unique id number assigned to them by SQL*LIMS, just like sample ids. The order in which samples are assigned to a worklist is called the SQL*LIMS sequence number and may be usable as an AMS sequence number for sample in a worklist.

Acidification & Spiking

WSRC		
Analytical Laboratories Department	4/28/2003	EBL Urine Engineering Process WorkFlow V1.1 Page 4 of 23

- **Identify the environment the sample will be in**
  - Is the sample in an office environment?
  - Is the sample to be placed in cold storage (liquid nitrogen), cold & wet, hot & wet, or hot water?
  - Is the sample to be placed in a hood or glove box?
    - This may indicate a harsh chemical environment
  - Does the sample transition from one environment to another?
- **Update the workflow diagram to capture the type of environment**

- ## What type of containers are the samples in?
  - Shape and curvature
  - Is the sample going into an instrument carrier?
  - Is the material of the container metal, glass, or plastic?
  - Do the sample containers change during processing?
  - Is the container re-used or a throw away?

- ## Update the Engineering Workflow diagram with the type of sample containers and if they change

- Does the barcode need to be a single unique number?
  - SQL*LIMS Sample Id Number?
  - Customer Id Number?
  - Does the unique id number change during processing?
- Is the sample to be aliquoted or sub-divided?
  - If so, do you want the sample id and the method?
- Update the Engineering Workflow to contain the data to be barcoded
  - Note where the barcode may be added to or changed

- Data to be tracked is one factor in determining barcode symbology. Most common codes in use at WSRC are:
  - Code 39
    - Variable length code with 44 symbols (upper case alphabetic, numeric, and $/+%
    - Medium density
    - Not very efficient use of space, produces long barcodes
  - Code 128
    - Variable length code with alphanumeric symbology with 106 distinct symbols
    - High Density
    - Very efficient use of space, can produce short barcodes
  - PDF417
    - encodes entire ASCII set (255 characters)
    - high density 2D code

- # The barcode label is one of the most critical part of the bar coding process

- # Review the Engineering Workflow diagram
  - ## Is the label exposed to a harsh environment(s)?
    - Environment determines the label material type and the adhesive
      - polyester (hot water, freezer, liquid nitrogen)
      - vinyl (solvent/chemical resistant, freezer, liquid nitrogen)
      - Matte White Nylon Cloth (freezer, liquid nitrogen)
      - Paper shipping label (water resistant only)
    - Get samples of each label type to test in the environment(s) from a supplier as recorded on engineering workflow
    - Test for the longest expected lifetime of the sample in the process flow as recorded on engineering workflow

–   What type of container is the sample to be held in?

   - The type of container determines the adhesive used for the labeling
   - If the container is to be re-used, a peel-able label is needed

–   What area on the container is available for printing?

   - Short, high curvature containers require labels be attached vertically and be of high density
   - If the sample container goes into an instrument container or rack, does the sample have to be exposed for instrument scanning?

– Does the sample require more than one label?

- If a record of the samples tested or received in an area is required, multiple barcodes may be need
- If a sample is aliquoted, additional barcodes will be needed if a SQL*LIMS sub-sample is not created
- These items may require a piggy-back label stock

– Note that not all label stock is suitable for use with all barcode symbology

– A barcode applied to a report does not necessarily require any special label

- An example of a poor choice in barcode label material
  - Barcodes applied to samples in hostile environment peeled and turn black
  - Obscured the SQL*LIMS id and other identifying numbers

- **Example of samples placed in instrument carrier or transport rack**

Non-Low Profile Label

Low Profile Label

With Label, Sample
Will Not Fit Into Container

With Low Profile Label, Sample
Will Fits Into Container

- Review the Engineering Workflow
- Choose locations where barcode printers will be used and update the Engineering Workflow
  - Dependent on number of labels printed and at what time in the process
  - Dependent on the type of barcode label printed
    - Bar code on report or analysis
    - Bar code label for application on a sample
- Type of barcode printer dependent on label stock and symbology
- Network barcode printers give the best utilization
  - Even non-network enabled barcode printers can be converted to network use

- Determine the software to generate the barcode labels
  - You can generate barcode labels from SQL*LIMS using Oracle Reports
  - Software used may be dependent on the type of printer used
  - Most common label printers used at WSRC is Zebra for barcode labels and laser printers for barcoded reports
- Special labels will require a dedicated barcode printer
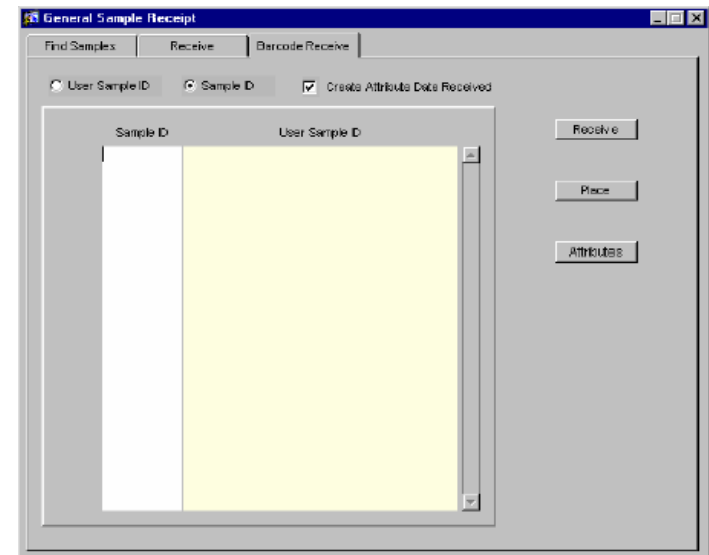 - Thermal transfer ribbon vs. laser printer

- Scanner type is dependent on
  - Location where scanning to be performed
  - Type of symbology used
  - Type of label being scanned
- Scanners may be
  - Connected to a PC via a "wedge" between keyboard and SQL*LIMS station (most common)
  - Mobile and require a receiving station
  - Be stationary (similar to food checkout)
- Scanners may be programmable
  - Will allow decoding of complex barcodes that are then parsed and sent out with imbedded tabs and carriage returns
- Update the Engineering Workflow to take into account the type of scanners needed in each area

- ## Sample Receiving
  - Area where biggest bang for buck can be achieved
  - Two flavors:
    - Receive from outside lab samples to be analyzed
    - Generate internal barcode label for samples
  - SQL*LIMS can receive samples by barcode from *Log, Sample Receipt, Barcode Receipt*

- ## Sample Tracking
    - Verifies sample is in a particular location for inventory purpose

- ## Documentation or report tracking
    - SQL*LIMS report has encoded the method id

- ## Task Processing
    - List of possible selections for standard results barcoded and on a laminated sheet
    - At SQL*LIMS client PC, operator scans solution into SQL*LIMS

- ## Custom Portal

  - Build a custom form that allows printing of labels on demand.

  - More flexible than SQL*LIMS Event printing

- ## Use ROWCALC to print labels at operation level

  - Allows printing of labels based on sample type via a custom PL/SQL package

  - Avoids problems with status actions at sample level

- **After implementation of bar coding wait a month**
  - Review Engineering Workflow times and processes
  - Note changes in work vs. process times
  - Update Engineering Workflow to new times and additional processes
- **Repeat review in 6 months and add additional changes as needed**
- **Generally, a 15-20% improvement is not unusual and can go as high as 30%**